

CO Protection for Escape Respirators

**Girish Srinivas
Steve Gebhard
Jason Vidaurri¹
Rita Dubovik
Brady Clapsaddle**

TDA Research, Inc.

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¹. Carbon Fiber Technology LLC

Outline

- Background
- Objectives
- Research Methods
- Results
- Conclusion

Background

Respiratory Protection

- For long term use (~30 min.), SCBAs are used (bottled air with hose and full face mask – cost \$2,000 – 3,000)
- Bottled air escape respirators (short term ~5 min.) use bottled air with a hood and airtight neck piece (cost ~\$600)
- Air purifying escape respirator for Chemical, Biological, Radiological and Nuclear (CBRN) hazard protection for ~15 minutes (cost ~\$250)



Escape Hood

Carbon Monoxide

- First Responders and Respirators
 - Police & paramedics (firefighters have access to SCBA)
 - Most common incidents are fire related (1.7 million fires in the U.S. in 2000, resulting in ~4,200 deaths)
- Civilian Escape from Fires
 - Fires produce hazardous compounds, including CO

Typical contaminant levels in fire smoke

<i>Contaminant</i>	<i>Typical Conc (ppm)</i>	<i>Max Conc (ppm)</i>	<i>IDLH (ppm)</i>
<i>Acrolein</i>	1.9	98	5
<i>Benzene</i>	4.7-56	250	3000
CO	246-1450	27000	1200
<i>HCl</i>	0.8-1.3	280	100
<i>HCN</i>	0.14-5.0	75	50
<i>NO₂</i>	0.04-0.7	9.5	50
<i>SO₂</i>	2.3	42	100
<i>Particulates (mg/m³)</i>	232	15000	<i>n.a.</i>

Escape Hoods

- Certified Escape Hoods for CBRN use are currently available
- Hood covers the head and neck and is made of laminate material
- Easy to put on, provides ~15 minutes of escape time
- Air flows through a canister (typically a carbon material)
- Exhaled air flows out of a separate valve
- Effective against CBRN
 - No hoods on the market that protect from CO
- New NIOSH certification requires CO protection
- NIOSH currently accepting applications for testing

NIOSH Design Criteria

- Requirements
 - 15 minutes of protection from 3,600 ppm of CO
 - Peak CO slip during 15 minutes should be no higher than 500 ppm
 - Testing to be done at 0°C with 64 slpm of air

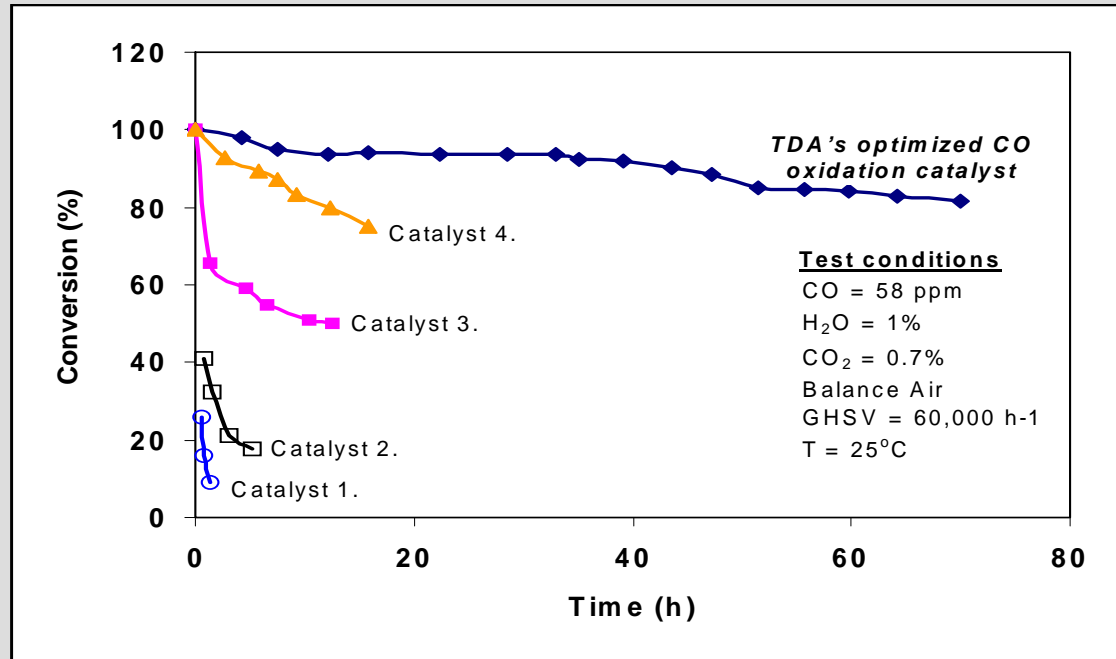
Objective

Objectives

- Develop a catalytic solution that can be added to existing escape respirators
- Catalyst oxidizes CO to CO₂ (lower toxicity)
- Catalyst needs to work under NIOSH specified conditions
- Test catalyst under a CDC SBIR Phase I extramural grant

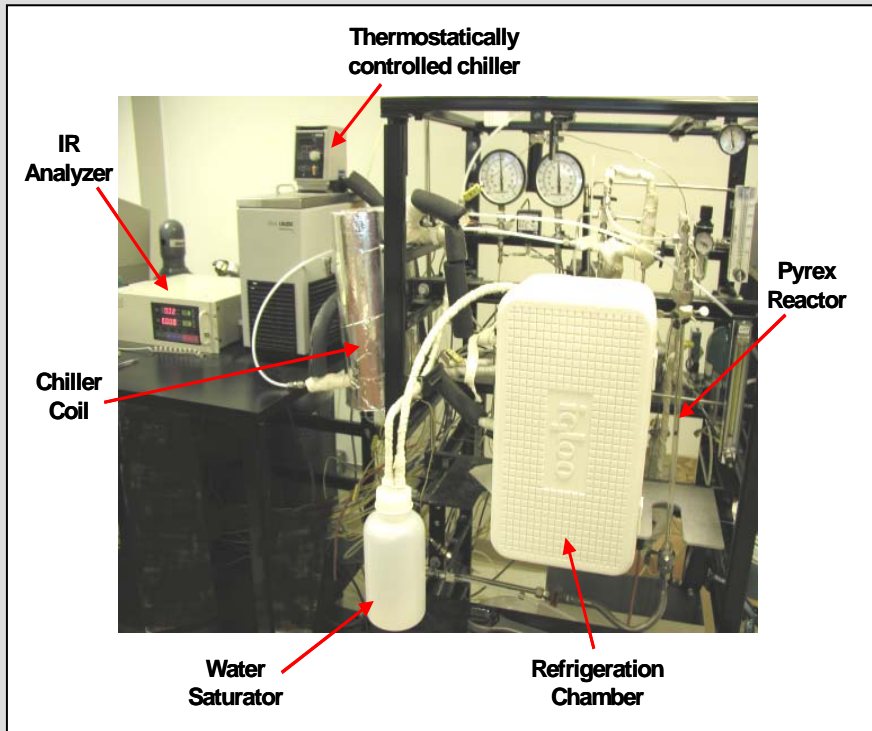
Research Methods

Catalysts for Low Temperature CO Oxidation



- Catalysts can oxidize CO in air at high temperature (>150°C)
 - Not at 0°C
 - Some need dry air

Experimental Apparatus

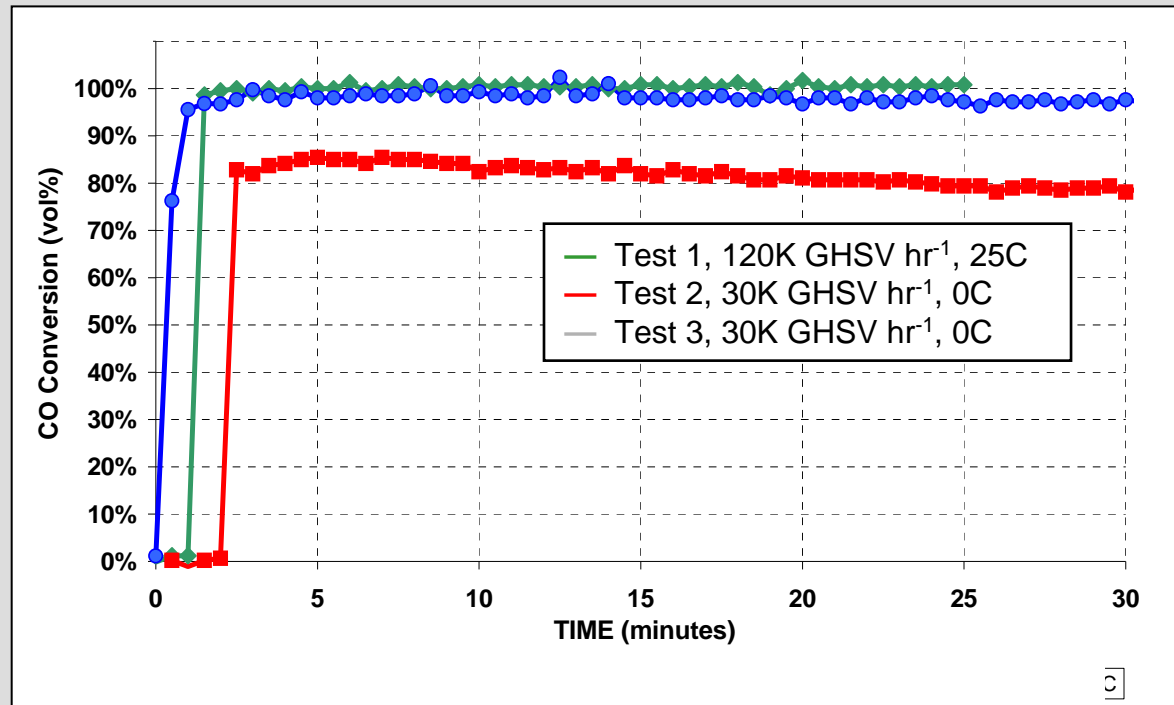


Test Apparatus

- Testing in TDA's labs using NIOSH protocol
 - 3600 ppm CO in air
 - 32°F (0°C)
 - 64 slpm (adjusted at TDA to give same space velocity in our smaller test bed)
 - Tested at GHSV of 30,000 to 120,000 hr⁻¹

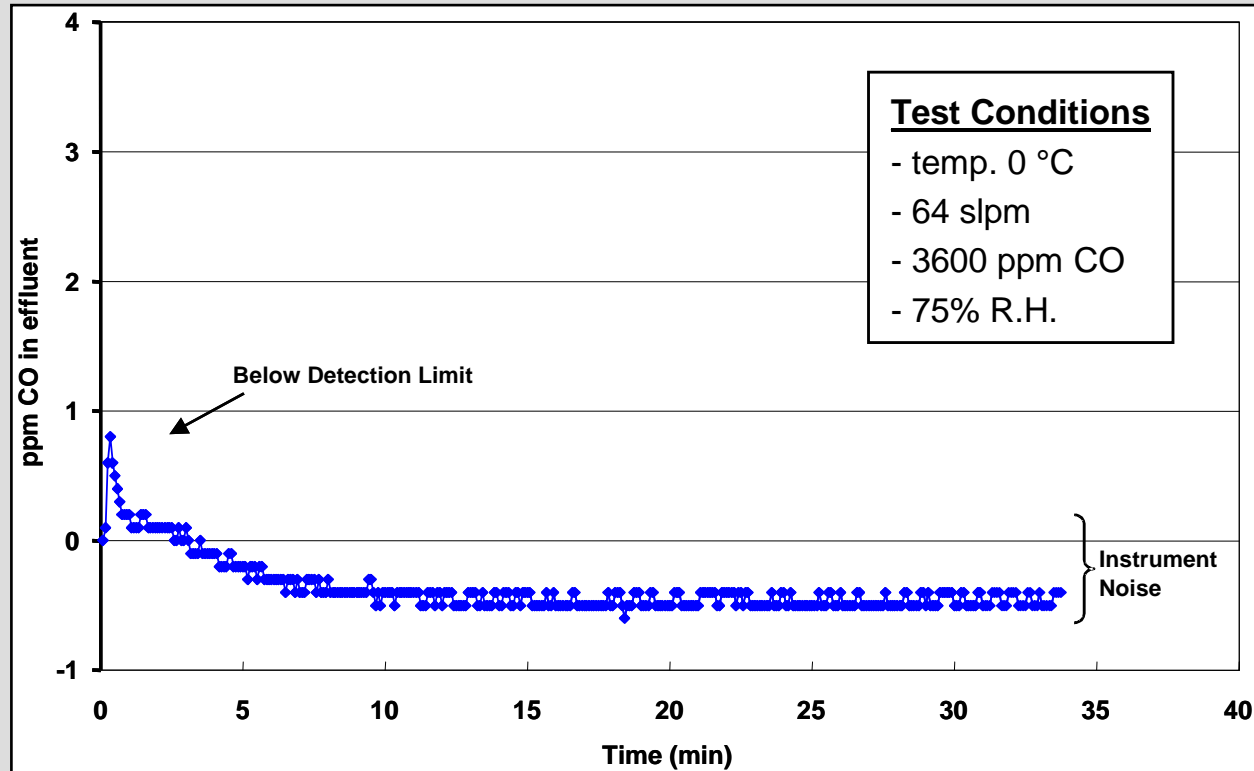
Results

Test Results – Laboratory Reactor



- 3600 ppm CO in air; 75% RH at 0°C (32°F)

Testing – Canister



- 64 slpm of 0°C air with 3,600 ppm CO
- Test for CO content in the outlet

Conclusion

Summary

- TDA's catalyst passes NIOSH test at small scale and in prototype scale canister
- In follow up effort,
 - Catalyst manufacture needs to be scaled up
 - Cost of catalyst (and canister) needs to be optimized/minimized
 - Prototypes need to be robustly tested

Impact

- Successful incorporation of CO catalyst into respirator will allow certification by NIOSH
- Respirator will protect civilians and first responders alike from harmful effects of CO
- Development may also have a significant impact on firefighter application

Acknowledgment

- NIH (NIOSH) for funding the SBIR project for proof of concept work